

FEMA's Flood Hazard Spatial Databases

Purpose of the New DFIRM Products

Since the 1970s, FEMA has been performing flood insurance studies and creating, storing, and updating flood hazard maps for National Flood Insurance Program (NFIP) communities across the United States and territories. FEMA maintains warehouses of paper maps, flood profiles, computer models on paper and disk, Letters of Map Change (LOMCs), and other paper data documenting this work. FEMA plans to take advantage of digital technologies to automate these products where possible, and to archive the data it collects in a computer readable format.

Several years ago, FEMA began focusing on producing Digital Flood Insurance Rate Maps (DFIRMs) as the first step in this process. Initially these maps were simply copies of the existing hard copy maps created using computer based drawing tools rather than manual drawing processes. FEMA then began producing some versions of its DFIRMs for use with Geographic Information Systems (GIS) technology. These products were "intelligent" maps, more than just digital drawings; in fact, computer-based analytic tools. With the new DFIRM products that FEMA is developing, the focus has been expanded to address the flood insurance study process as a whole. The new FEMA databases developed by the DFIRM working group are intended to create fully digital records of the FEMA flood insurance study process. These databases are designed to be the building block for a more robust, interactive, digital map.

The new FEMA GIS databases will store the digital data used in the map production process, as well as the backup engineering data for the floodplain studies. These databases will provide a standard, systematic method for FEMA to distribute comprehensive details of its flood studies to the public in a digital format.

Storing and distributing this data in digital format has significant advantages for ease of storage, records search, and distribution. But, the biggest advantage of the FEMA databases is that the data is stored as intelligent GIS data. The FEMA databases can be used for automated analysis and map updates that are not possible with the current paper products.

In the future, FEMA's contractors and mapping partners will use the database as the primary format for data exchange. The standard structure will facilitate the development, open exchange, rapid map updates, and dissemination. Currently, FEMA is revising its Guidelines and Specifications to formulate new submission requirements for Study Contractors, Cooperating Technical Partners (CTPs), and other mapping partners that will be based on these new product formats. Beginning immediately, FEMA would prefer to have data submitted in this format.

For data submissions, FEMA will try to collect as much data as possible in GIS database format for each DFIRM map created. For publication of this data, FEMA will provide a simplified version of the database for end users that are not interested in the complete

engineering backup data. This document describes the simplified product that FEMA will publish, the Standard DFIRM Database. This simplified version of the database is not intended to limit the scope of the GIS data collected and submitted to FEMA.

The overall development of the new DFIRM products is one of the largest single components of Map Modernization. In addition to the Standard DFIRM Database development, FEMA has workgroups developing revised graphic specifications, policies for the use of the digital data, plans for the distribution of new digital products, and tools for viewing and using DFIRM products.

Database Versions of the DFIRM Products

FEMA has always had at least two distinct user communities for its products – the insurance industry and floodplain managers. The insurance, lending and flood risk determination community needs to easily determine the flood risk at a particular location. This information is used to determine whether the purchase of insurance is mandatory for particular real estate transactions and to determine the correct insurance rates for structures that are insured. The Flood Insurance Rate Map (FIRM) was developed by FEMA as the tool for these users.

The other major user group is comprised of floodplain managers who regulate development in the floodplain in NFIP communities, water resources engineers, and the groups they work with who are developing projects in and near Special Flood Hazard Areas (SFHAs). These users require more detailed information about FEMA flood risk analysis. They rely on FEMA's Flood Insurance Study (FIS) report and flood profiles in conjunction with the cross section and floodway information shown the FEMA maps. These users frequently request additional detail, such as the actual computer models and topographic information in the flood hazard study.

To meet the needs of the two user groups, FEMA is developing two versions of the GIS database. The Standard DFIRM Database is the GIS data product designed for users who principally need to determine the flood zone, base flood elevation and other detailed information needed for flood insurance at a particular location. The goal of this product is to make it as simple as possible, while still providing all the information that this user group needs.

The more extensive database product, the Enhanced DFIRM Database, is being designed to be comprehensive and provide a structure for storing the data produced and collected during a flood insurance study. The details of the FIS Database are under development and will be forthcoming.

It is important to note that the distinction between the Standard DFIRM Database and the Enhanced DFIRM Database is mainly a distinction in the way FEMA packages its data for distribution. FEMA collects and maintains more detailed data than can be displayed on the FIRM; the agency's long-term goal is to build a complete Enhanced DFIRM Database for each of its studies.

The Standard DFIRM Database Definition

Because the Enhanced DFIRM Database product is envisioned to be so comprehensive and the process of developing a detailed database definition requires a great deal of work, the workgroup has focused to date on the detailed definition of the Standard DFIRM Database.

The first version of the Standard DFIRM Database was published by FEMA on July 21, 1999. Based on feedback from public review and CTPs, a number of changes have been made to the Standard DFIRM Database. Primarily the scope of the Standard DFIRM Database has been narrowed slightly. Many optional fields have been removed to simplify the tables and some tables were eliminated that were required only for cartographic purposes or for purposes beyond the scope of the Standard DFIRM Database. In addition, tables were added that list the engineering models used in the flood study in order to tie into the model links incorporated into the cross section line tables. To capture transportation labels near the SFHA, transportation related tables were added to the database.

Standard DFIRM Database Elements, where applicable:

- Digital Orthophoto Quadrangle or transportation features with feature labels
- Public Land Survey System
- Flood hazard areas (1% and 0.2% annual chance flood hazard areas and floodways)
- Hydrographic features (streams, lakes, shorelines)
- FIRM panel areas, including the effective date, size, scale, and corner coordinates
- Political areas (corporate and county boundaries as well as National Parks, forests, and military lands)
- USGS 7.5-minute quadrangle areas
- Coastal Barrier Resources System (CBRS) areas
- Base (1% annual chance) Flood Elevation (BFE) lines
- Mapped cross section lines, including the BFEs added from the Flood Insurance Study
- Coastal transects
- Permanent benchmarks with NGS Permanent Identifier
- Structures (dams, bridges, culverts, weirs, levees etc.)

Enhanced DFIRM Database

The goal of the Enhanced DFIRM Database is to archive in an electronic and systematic format all of the data collected during the production of a FIS in a specific format. The Enhanced DFIRM Database will contain all elements in the Standard DFIRM Database as well as additional spatial elements and database tables where all available of the engineering, modeling, surveying, topography, and mapping data are archived. These tables contain engineering, modeling, surveying, topography, and mapping data. These

GIS mapping layers and related tables provide details for the flood hazard analyses but generally are not shown on the paper DFIRM product. Examples of features the Enhanced Database may include are: contours or DEM data, stream reaches, soils, land use, basin and sub-basin outlines, and high-water marks. Individual points along features such as cross sections are also included.

Design Principles for the Standard DFIRM Database Product

Where possible, all mapping and engineering data elements will be linked to physical geographic features and georeferenced. GIS provides the ability to georeference and overlay the mapping and engineering data. This approach supports a wide variety of existing and visionary FEMA engineering and mapping products, such as digital mapping; automated hydrologic and hydraulic (H&H) modeling; automated mapping; Web-based publishing; and direct links between modeling and mapping elements.

The DFIRM Database workgroup has taken a comprehensive approach to capturing the full array of data elements and attributes comprising the end-to-end engineering and mapping processes required to generate FEMA's DFIRM products. All aspects of data collection and processing have been analyzed to support the tasks of FEMA's Study Contractors (SCs), Flood Map Production Coordination Contractors (MCCs), CTPs, collaborating Federal agencies, customers, and end-users. Although the details have only been completed for the Standard DFIRM Database, the entire picture has been considered in the design process.

For data submissions to FEMA and processing of flood hazard data by FEMA, there is no distinction between the Standard DFIRM Database and the Enhanced DFIRM Database. FEMA will try to collect as much data as possible in GIS database format for each DFIRM map created. The Standard DFIRM Database is just a simplified version of the comprehensive Enhanced DFIRM Database for users who do not want to see the complexity of the full database. However, FEMA always faces difficulty in converting existing information into updated digital formats. Because of funding limitations, when existing flood data in hard copy format is incorporated into a new DFIRM map, the amount of detailed information that can cost-effectively be converted to digital format is limited. Many DFIRMs, or parts of DFIRMs, will be created by digital conversion. It will generally only be possible to create Standard DFIRM Databases for these products, not Enhanced DFIRM Databases.

As the workgroup progressed on the Standard DFIRM Database product design, a number of basic decisions were reached that helped guide the overall decision making: the use of abbreviations; the use of standard database practices; the purpose of the database concerning paper map replication; use of internal processes; and the definition of optional and required elements. The published data will avoid utilizing abbreviations and codes where possible. This decision was driven primarily by negative feedback on earlier FEMA products in DLG format products where all the information is encoded versus positive feedback on the Q3 formats that included plain English attributes that were more easily understood.

The database will be designed to be usable in a standard Relational Database Management System, but will be software independent. Therefore the products are defined as flat tables in public domain formats (e00 files, shapefiles, mif files). These formats can be imported into a wide variety of software packages. They manage GIS data in discrete files, generally organized by data theme. As a result, they do not support the inter-table relationships and data integrity enforcement capabilities of a RDBMS. However, the data produced by FEMA will be designed and tested to follow these rules and, therefore, will be structured to be fully compatible with a RDBMS.

The purpose of the Standard DFIRM Database is not to allow someone with the database product to produce an exact replica of the printed map. Instead the Standard DFIRM Database is designed to allow a GIS user access to all of the same information conveyed on the FIRM in a way that can best take advantage of the automated analysis capabilities of GIS. FEMA will publish a companion product consisting of a scanned version of the DFIRM that will allow users to reprint exact replicas of the entire FIRM panel or portions of the FIRM panel.

The Standard DFIRM Database product is not necessarily the same as the internal tool or database used by MCCs, CTP or SCs in their internal work. Each user may find the need for additional fields or table that support their own work. When there are conflicts between having the best cartographic representation of a feature, or the most accurate digital data, or incurring significant additional costs to achieve both, the accurate digital data is the most important.

The Standard DFIRM Database may have optional and required elements. But, the optional and required classifications are different from the Standard DFIRM Database and Enhanced DFIRM Database elements. The Standard DFIRM Database may have fields for optional and required information. The Enhanced DFIRM Database will have fields that are required and optional. The optional fields are designed to allow the DFIRM product to continue to modernize as technology progresses and capture available information rather than limiting the product to the bare minimum necessary. The Standard and Enhanced DFIRM Database distinction only exists to hide the complexity of the backup engineering data.

Metadata

The Standard DFIRM Database is designed to accommodate the storage of metadata (or data about the data) at multiple levels. Metadata can be stored at the individual feature level if different features in one map layer were derived from multiple sources. The use of feature-level metadata supports future map updates by FEMA or its partners who revise only portions of a DFIRM.

Most of the Standard DFIRM Database's metadata is stored in a single FGDC compliant metadata file. The FGDC format allows for separate source citations to describe different classes of data that are incorporated into the dataset. Each element in the Standard

DFIRM Database has a source citation attribute. This attribute makes it possible for each attribute to be referenced to a specific source citation in the metadata file.